

REMARKS

The applicants thank the Examiner for the thorough examination of the application. No new matter is believed to be added to the application by this amendment.

Status of the Claims

Claims 1-3, 5-8, 12-16, 18-22 and 27 are pending in the application. Claim 26 is cancelled by this amendment. Support for the amendments to claim 1 find support at page 4, lines 21-24 and at page 6, lines 15-23 of the specification. The amendments to independent claims 7, 15 and 19 incorporate subject matter from cancelled claim 26, which found support at page 4, lines 21-24 of the specification. Claims 27 finds support in the specification at page 5, line 25 to page 6, line 5 and at page 8, lines 15-21.

Rejections Under 35 U.S.C. §103(a) Based On Murasawa and Eckberg (Paragraphs 1-3 of the Office Action)

Claims 1, 2, 6-8, 12-16, 18-22 and 26 are rejected under 35 U.S.C. §103(a) as being obvious over the combination of Murasawa (U.S. Patent 5,547,823) with Eckberg (U.S. Patent 5,583,195). The Examiner adds the teachings of Heller (U.S. Patent 5,854,169) to the aforesaid rejection, as applied to claims 1 and 2, to reject claims 3 and 5 under 35 U.S.C. §103(a). Applicants traverse.

The Present Invention and its Advantages

The present invention pertains to a novel photocatalyst that has many embodiments, and a typical embodiment can be found in instant claim 1:

1. A high-function photocatalyst having its surface partially covered with a polymer having an anionic group, said polymer leaving uncovered photocatalyst surface,

wherein the polymer is selected from the group consisting of poly(fluorine-substituted sulfonic acid), poly(fluorine containing carboxylic acid), polystyrene sulfonic acid, and polyvinyl sulfonic acid, and

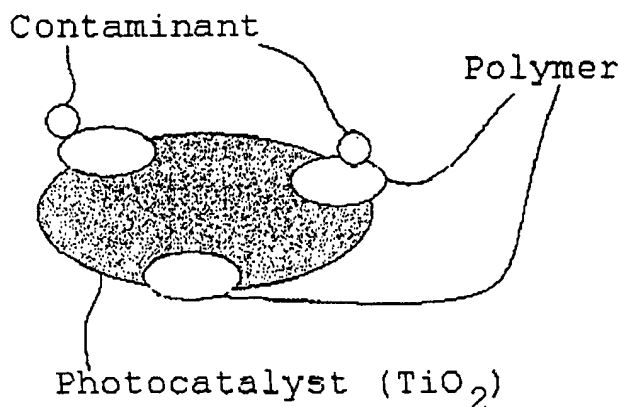
wherein said partially covered surface is prepared by applying a polymer solution in an amount of 0.05 to 0.4 ml with a 5% by weight solution to the photocatalyst surface per gram of the photocatalyst,

whereby the polymer having an anionic group attracts pollutant materials having a positive charge so close to said photocatalyst surface as to promote photocatalytic decomposition of the pollutant materials.

One of the important features of the present invention resides in that a partially covered surface is prepared by applying a polymer solution in an amount of 0.05 to 0.4 ml with a 5% by weight solution, per gram of the photocatalyst, i.e., 2.5 to 20 mg/g. Thus the photocatalyst has its surface partially covered by a polymer having an anionic group. In the invention, the anionic group can attract and hold a negative contaminant. Because the photocatalyst's surface is partially covered, when the anionic group traps a contaminant, this contaminant is brought into close proximity with the photocatalyst. The photocatalyst thereby easily and effectively decomposes the contaminant.

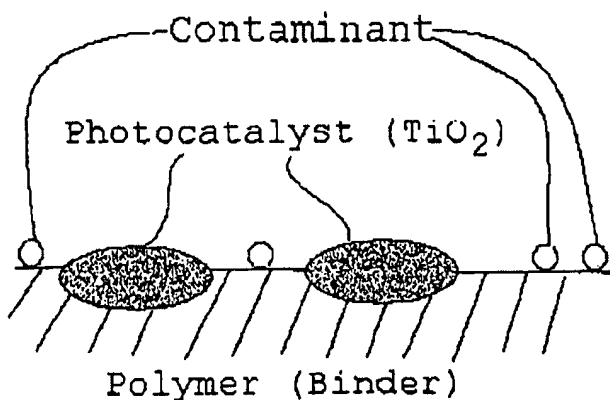
Since the polymer has an anionic group, the charge (electron) of the contaminant may transfer to the photocatalyst, whereby a radical may be produced. This radical further accelerates decomposition of the contaminant.

An illustration of an embodiment of the invention is reproduced below.



The above illustration shows that the amount of TiO₂ is significantly large when compared to the polymer. Therefore, when a contaminant adheres to the polymer, TiO₂ in the vicinity of the polymer effectively decomposes the polymer.

In contrast, the conventional art technology is illustrated below.



Here, the contaminant is far from TiO₂ and is hardly decomposed.

The conventional art illustrated above utilizes an amount of polymer (binder) that is very high when compared to that of TiO_2 . If a contaminant particle becomes trapped by the polymer, the decomposition effect is unsatisfactory.

Also, the photocatalyst of the conventional art is buried in the polymer so that only a part of the photocatalyst is exposed. As a result, there is only a limited amount of the surface area of the photocatalyst available to react with the contaminants. Accordingly, the small effective area of the photocatalyst results in unsatisfactory decomposition of pollutants.

As follows from the above graphical explanations, the present invention has an optimal concentration of polymer that is lower than that of the conventional art, because the inventive photocatalyst is only partially covered by polymer. The present invention accordingly uses an amount of polymer that is preferably as small as 0.05 to 0.4 ml in 5% by weight solution per g of photocatalyst (see claims 1, 7, 15, 19).

Also, the present invention shows unexpected results over the conventional art technology typified by Murasawa, Eckberg and Heller. These unexpected results are shown in the Declaration by Keiichi Tanaka, which is being filed concurrently with this paper, which will be discussed in further detail below.

Distinctions Of The Invention Over Murasawa, Eckberg and Heller

Distinctions of the invention over Murasawa and Eckberg have been placed before the Examiner. For brevity, this distinctions are not repeated in detail here.

As noted in previous Responses, Murasawa fails to disclose polymers capable of electron transfer and attracting pollution materials (such as an anionic polymer), because Murasawa does not aim at improving catalytic activity but requires binder to merely fix a photocatalyst onto a substrate. Murasawa further fails to disclose a partially covered photocatalyst. Also, at page 3, lines 1-2 of the Office Action, the Examiner admits: "Murasawa '823 fails to disclose a poly(fluorine-substituted sulfonic acid)."

Further, in the present invention the amount of polymer is defined as the amount to partially cover the photocatalyst surface. As set forth in instant claim 1, the range is from 0.05 to 0.4 ml of a 5 wt% polymer solution, per gram of the photocatalyst, i.e., 2.5 to 20 mg/g. As a result, the polymer and the photocatalyst synergistically associate with each other to obtain an enhanced catalytic activity (as shown in the attached Declaration).

In contrast, the photocatalyst composition of Murasawa has a polymer amount of 0.8 g per 9.8 g of photocatalyst (see Murasawa at column 6, lines 55-61), i.e., 82 mg/g. As the results in the Declaration demonstrate, this 82 mg/g polymer loading is too large to conduct an effective photocatalytic decomposition due to the undesirable adsorption of pollutant materials.

This excessive use of polymer in Murasawa arises from this patent's objective of firm adhesion of the photocatalyst to substrates such as office walls (see Murasawa at column 1, lines 53-63 and at column 2, lines 24-28). That is, a large amount of firm adhesive polymer is required to fix the photocatalytic particles by burying them in the polymer. For this purpose, although Murasawa may use less degradative polymers, this use has no bearing on the pollutant-attracting polymers of the present invention.

In contrast, the present invention exhibits very high activity for the decomposition of pollutant materials. In the present invention, photocatalytic decomposition is efficiently achieved in a liquid phase such as a water suspension (but is not limited to such). The paragraph starting at page 5, line 25 of the specification describes this decomposition: "Using the photocatalyst of the present invention, these compounds contained in water can be decomposed at high efficiency. The decomposition process can be conducted by that the wastewater to be treated is brought into contact with the photocatalyst, and irradiated with ultraviolet ray."

In contrast, Murasawa fails to show liquid phase catalytic activities, but is limited to conventional gaseous phase decomposition of NO_x, acetadehyde or methyl mercaptan. The catalyst of Murasawa is substantially inactive in a liquid phase, as is experimentally demonstrated (in the Declaration) when viewed in terms of the amount of polymer used.

Eckberg and Heller also fail to disclose or suggest a photocatalyst covered with polymer that can attract pollutant materials. Eckberg merely discloses fluoro sulfonic acid polymer. Heller merely discloses a particle size of 1-50 nm.

As a result, one having ordinary skill in the art would not be motivated by Murasawa and Eckberg to produce the present invention as embodied in independent claims 1, 7, 8, 15 and 19. Heller fails to address the deficiencies of Murasawa and Eckberg. A *prima facie* case of obviousness has thus not been made. Claims depending upon independent claims 1, 7, 8, 15 and 19 are patentable for at least the above reasons.

Further, even if one assumes *arguendo* that Murasawa, Eckberg and Heller are sufficient to allege obviousness, this obviousness would be rebutted by the unexpected results of the invention. Attached, please find a Declaration Under 37 C.F.R. §1.132 by Keiichi Tanaka.

The Declaration compares the low polymer loading of the present invention (Experiment 1, 4.5 mg/g) compared to high polymer loadings (Comparative Experiments 1 and 2, 45 mg/g and 67.5 mg/g) that are typical in the conventional art such as Murasawa. The results are shown in Table A, which is reproduced below.

	Experiment 1	Comparative Experiment 1	Comparative Experiment 2
Amount of Nafion provided on photocatalyst.	4.5 mg/g	45 mg/g	67.5 mg/g
Adsorbed amount of herbicide after stirring for 120 min.	10% (0.1×10^{-4} mol/l)	50% (0.5×10^{-4} mol/l)	90% (0.9×10^{-4} mol/l)
Photocatalytic decomposition amount of herbicide with 10 minutes light irradiation	60% (0.6×10^{-4} mol/l)	45% (0.45×10^{-4} mol/l)	Not conducted

As a result, the present invention clearly shows results that are superior to the high polymer loadings of the conventional art. These unexpected results thus fully rebut any obviousness that can be alleged over the present invention.

These rejections are overcome and withdrawal thereof is respectfully requested.

Prior Art

The prior art cited but not utilized by the Examiner indicates a status of the conventional art that the invention supercedes. Additional remarks are accordingly not necessary.

Information Disclosure Statement

Applicants thank the Examiner for considering the Information Disclosure Statement filed June 7, 2001 and for making the initialed PTO-1449 form of record in the application in the Office Action mailed November 19, 2003.

The Examiner is respectfully requested to consider the Information Disclosure Statement filed June 16, 2004 and to make the initialed PTO-1449 form of record in the application in the next official action.

Foreign Priority

The Examiner has acknowledged foreign priority in the Office Action mailed November 19, 2003.

Conclusion

Should there be any outstanding matters that need to be resolved in the present application, the Examiner is respectfully requested to contact Robert E. Goozner, Ph.D. (Reg. No. 42,593) at the telephone number of the undersigned below, to conduct an interview in an effort to expedite prosecution in connection with the present application.

Pursuant to 37 C.F.R. §§ 1.17 and 1.136(a), Applicant(s) respectfully petition(s) for a one (1) month extension of time for filing a reply in connection

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Amendment of July 11, 2005
Response to Office Action of March 11, 2005

Docket No.: 0234-0421P


with the present application, and the required fee of \$120.00 is attached hereto.

If necessary, the Commissioner is hereby authorized in this, concurrent, and future replies, to charge payment or credit any overpayment to Deposit Account No. 02-2448 for any additional fees required under 37 C.F.R. §§ 1.16 or 1.17; particularly, extension of time fees.

Dated: July 11, 2005



Respectfully submitted,

By 

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Attachment: Executed Declaration Under 37 C.F.R. 1.132